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RATE OF MIGRATION OF CREPIDULA CONVEXA SAY

BY H. E. VOKES

University of California, Berkeley

Among the species inadvertently introduced into the fauna of San Francisco Bay together with the spat of *Ostrea virginica* Gmelin, was *Crepidula convexa* Say.¹ Collections made by the writer from the littoral zone at Moss Beach, San Mateo County, California, during the summer of 1933 were found to contain eight specimens of the latter form. This common, Eastern species thus seems to have become firmly established on the Pacific Coast and to have adapted itself to the waters of normal salinity in the Pacific Ocean proper, as well as to the waters of San Francisco Bay.

The introduction of this species was first reported (as *Crepidula convexa* Say var. *glauca* Say) in a note on NAUTILUS by R. E. C. Stearns in 1899.² He stated that H. Hemphill had collected a series of 30 or 40 specimens in the oyster beds at the southern end of San Francisco Bay. In 1918 E. L. Packard³ reported that the *Albatross* collections made during the biological survey of 1912-1913 contained 115 individuals from the region where the first specimens had been obtained, and 18 from off the Alameda shore. This is approximately 12 miles from the original locality and indicates a rate of migration of about one mile per year.

The discovery of this species at Moss Beach represents the first report of its presence in the waters of the Pacific Ocean proper.

¹ Say, T., Jour. Acad. Nat. Sci., Phila., vol. 2, p. 227; 1822.

² Stearns, R. E. C., Nautilus, vol. XIII, No. 1, p. 8. Communication dated March 10, 1899.

³ Packard, E. L., Univ. Calif. Publ., Zoology, vol. 14, no. 2, p. 322, 1918.

Collections were made almost daily over a period of five weeks and the occurrence of but eight specimens suggests that this region marked the limit of its southern range. This would indicate a migration of approximately 46 miles from the area where it was first reported in 1899 and shows an average rate of approximately one and one-third miles per year.

The apparent discreancy between the rates of migration to be noted in the stations reported by the *Albatross* and the occurrence here noted at Moss Beach admits of two possible explanations. It may be explained as due to an actual increase in the rate caused by the effect of current movements. However the only area in the region traversed where the currents are markedly strong is at the mouth of San Francisco Bay. Here, particularly during the period of the outgoing tides, a marked acceleration of the speed of migration may be expected. *Crepidula* is, however, a benthonic form and does not possess a free-swimming larval stage. Moreover, only some five or six miles of the entire 46 miles traversed is within the influence of this area, and the resulting rate of migration if correction is made for this zone is still in excess of that noted for the *Albatross* collections.

Another possible explanation is that a certain length of time passed during the years immediately after the species was introduced; in these years it was establishing a population of sufficient magnitude to make matings more than a chance occurrence, and was thus developing a sufficient degree of competition to require expansion of its range. When correction is made for this feature the actual migratory rate may be well in excess of one and one-half miles per year; although the rate of one and three-quarters miles indicated as between the *Albatross* and Moss Beach occurrences is probably excessive, due to the influence of the currents at the mouth of the bay.

It is of interest to compare this observed rate of migration of *Crepidula convexa* with that observed for *Littorina littorea* Linnaeus when introduced on the Atlantic Coast. Accounts differ, but all⁴ agree that the species first appeared in the vicinity of

⁴ See:

Morse, E. S., Bulletin of the Essex Institute, vol. 12, pp. 173-176; 1880.
Smith, S., Proc. Nat. Sci. Assoc. of Staten Island, vol. 1, p. 61, Jan. 14, 1888.

Halifax, Nova Scotia, about 1852-57, and was first reported at Portland and Kennebunk, Maine, in 1870. (Suggesting again the need of a certain period of time to permit the development of a population of sufficient size to permit and require dispersal.) Migrating with the Labrador current the species appeared at Salem and Provincetown, Mass., in 1872; averaging at least 60 miles per year between Kennebunk and Provincetown. Apparently experiencing difficulty passing around Cape Cod, it did not reach Wood's Hole until 1875. From here on its rate of migration speeded up again, though proceeding against the current, and it reached New Haven in 1880, averaging approximately 23 miles per year. It was first reported at the Narrows at Staten Island in 1888,⁵ but the long sandy beaches, lacking intervening rocky shores or shingle beach, appear to have effectively prohibited much further movement as the latest report available indicates that the present southern range of the species is New Jersey.⁶

The marked contrast between the rate of migration observed for the two species does not readily admit of explanation. Fundamental differences in the habits of the two species are probably the most significant causes. It is also evident that although conditions are sufficiently favorable to permit the establishment and migration of *Crepidula convexa*, they are not as near the optimum as the environment of the Atlantic Coast proved to be for *Littorina littorea*.

CYPRAEA TIGRIS LINNÉ IN THE HAWAIIAN ISLANDS

BY WRAY HARRIS

For many years naturalists have believed it probable that the range of the tiger cowrie includes the Hawaiian Islands, although heretofore no definite proof of this has come to light. A few dead shells have been picked up at the beaches, and at least one specimen has been dredged in Honolulu harbor. *Cypraea tigris* is of widespread occurrence in the Pacific, and many specimens from

⁵ Jacot, A. P., Nautilus, vol. 33, p. 115, 1920.

⁶ Johnson, Proc. Boston Soc. Nat. History, vol. 40, no. 1, pp. 1-204; 1934.